



# Ethernet-Based PROFINET Integration of Field Instruments in the Water and Waste Water Industry

- One cable for all – continuous communication from the control room to field level
- Simultaneous transmission of process and diagnostic data such as flow conductivity, flow speed, temperature etc. using one cable
- Less downtime by simply swapping instruments
- No additional costs for fieldbus hardware or analogue signal transmission technology

## Background:

In the water and waste water industry a large volume of process data is still transmitted from the field via conventional point-to-point wiring, such as the measured flow value of an electromagnetic flowmeter (EMF). One process value can be transferred for each pair of wires, e.g. over a 4...20 mA signal.

The demands of operators have steadily changed over past years. External influences, such as changing maintenance concepts and energy efficiency measures, have led to an increased demand for information from field level. There is no economically efficient way of achieving this with conventional point-to-point wiring.

One alternative for plant operators is to use fieldbus protocols such as Modbus® or PROFIBUS®, which allow the transmission of several process values over one cable. However, this type of communication requires additional hardware in the form of special cable or fieldbus-couplers (e.g. PROFIBUS® Master). These are highly complex communication channels and present huge challenges to operating staff.

Communication between the control system and a bus-controlled field instrument, via PROFIBUS® for example, requires Ethernet-based

communication from the control system to the automation level (PLC, programmable logic controller). Information is sent from the programmable controller (PLC) to the field instrument over a PROFIBUS® protocol via PROFIBUS® Master.

## Real-life challenge:

In an effort to make processes and services more and more effective and cheaper, cost-cutting is on the increase with regard to staff at the plants. Fewer staff who are unfamiliar with the remit are thus faced with increasingly complex technology. They are dependent upon highly customised, integrated systems as they cannot handle the individual components in depth.

One of the key demands is, therefore, that the field instruments be simply integrated into the process control system to allow independent handling.

Another focal point is the cost-optimised transmission of advanced maintenance and process information from the field instrument.

A typical example from the wastewater industry is an integrated conductivity measurement in a flowmeter. Electrical conductivity is one

of the indicators that provides information about the quality of water and wastewater. As a rule, the wastewater from an indirect discharger or a communal inlet area has a known average electrical conductivity. If the measured electrical conductivity differs greatly from the average value, there is reason to assume an unauthorised discharge. This then leads to further tests. A conductivity measurement integrated in a flowmeter already installed in the pump stations substantially reduces the cost of installation, integration and maintenance. The operator can use either several analogue outputs or various bus technologies to transmit the data from the flowmeter to the control technology. However, this method does not allow continuous communication via a protocol from the field instrument to the control room.

Given the increased costs of additional hardware such as multiple analogue outputs for the flowmeter, isolation amplifiers and fieldbus components as well as the associated costs for integration into the control technology and maintenance, more and more operators are looking for alternative solutions.

### Implementing the solution:

Manufacturers of field equipment are faced with the challenge of meeting the operators' need for more detailed maintainer information and other process data from the field instrument whilst ensuring simple integration in the control technology.

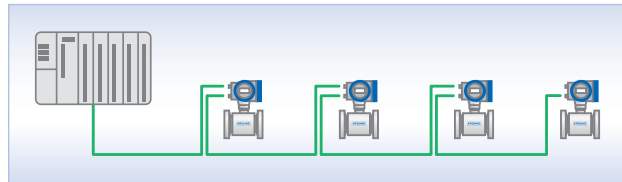
The Ethernet-based communication protocol PROFINET allows the standardised and manufacturer-independent transmission of all the relevant process data.

A PROFINET-capable field instrument, in this case an EMF, is directly integrated in the automation network by means of a PROFINET switch via PROFINET cable, instead of expensive wiring via isolation amplifier technology, transmission terminals and analogue PLC input modules. The OPTIFLUX 2000 EMF with IFC 300 converter also features an integrated PROFINET switch which, in addition to star topology, also enables line or ring topology, and depending on the structure of the system means that a separate PROFINET switch is not required.

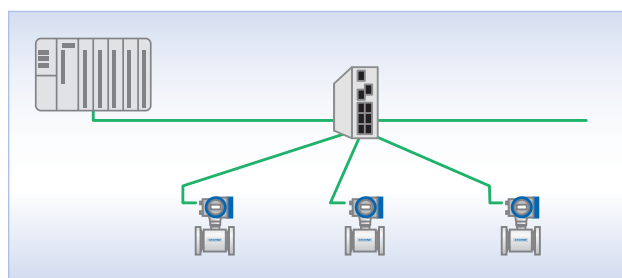
The Ethernet wiring takes the form of conventional Ethernet network connectors (M12) and a usually green PROFINET data cable. In addition to the RJ45 connectors commonly used in IT, the PROFINET specification stipulates industrial-strength M12 connectors. The measuring device comes with one or two M12 bushings, depending on the system topology requested (star, line or ring). This makes connection errors (voltage reversals) virtually impossible. The data is directly available to the control on an Ethernet-basis. There is no need for the costly conversion of fieldbus protocols to Ethernet-based protocols in the PLC.

### Network topologies

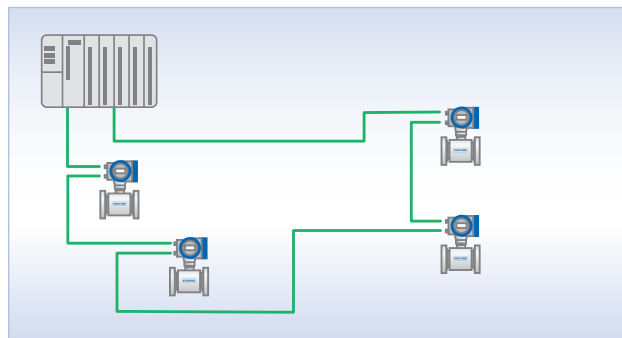
The integrated PROFINET switch allows for line topologies: multiple devices can be connected without the need for an external switch. In this case the field instrument has two M12 bushings, allowing several field instruments to be interlinked via one switch integrated in the field instrument.



Depending on the application, star topology is also possible with an external PROFINET switch. In this case, the field instrument has one M12 bushing



If the application requires redundancy, KROHNE's PROFINET interface can also be deployed in ring topology. In this case, the field instrument has two M12 bushings. This means that several field instruments can be interlinked via one switch integrated in the field instrument.



The field instrument is integrated into the automation in the PLC's programming software from the selection list by dragging and dropping. The driver files required for this (GSD files for PROFINET) are provided by the instrument manufacturer, downloaded and then imported to the programming software. In the next step, the instruments are automatically named via the PLC's programming software; every PROFINET subscriber available in the network receives a PROFINET name from the specified namespace. With PROFINET the instrument is uniquely identified and searched for by its PROFINET name, and not the IP address.

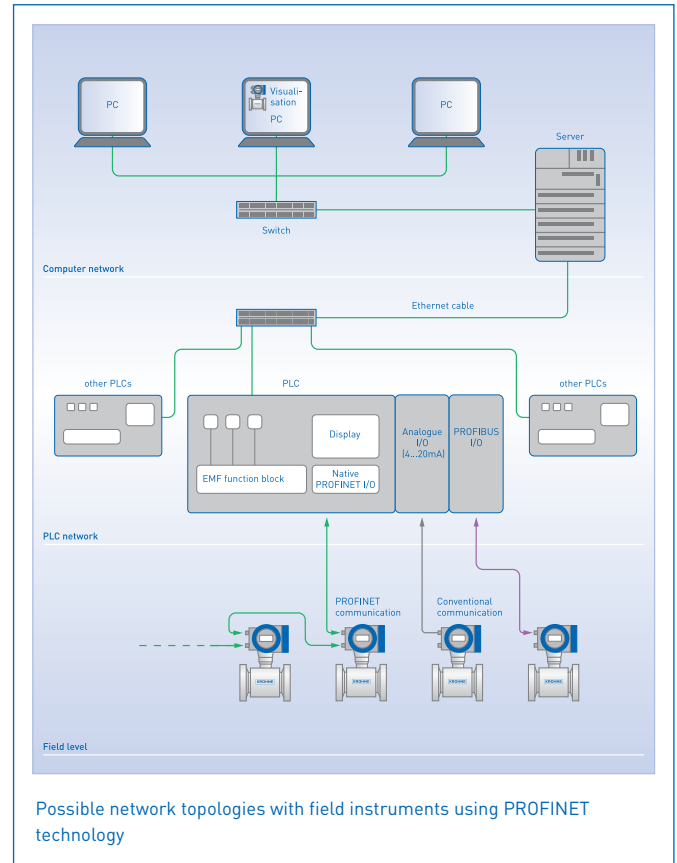
The instrument is now connected to the PLC and is available as a subscriber in the bus cable, however, the data cannot yet be used – the operator needs to fragment the data items received using the documentation provided and process the relevant information from the field instrument in the PLC (the relevant bit structures for status messages

etc. are converted to single bits). This method is second nature to a programmer, but difficult for an operator. This step is necessary to be able to use the information provided by the field instrument in the PLC's application program.

Nowadays, the application program for controlling the field instruments is created on the PLC in a graphical programming language. Complete graphical function blocks for integrating the field instruments are available to help the user with start-up and troubleshooting.

In the block library, the conversion to single bits is carried out beforehand in the case of a bus-controlled field instrument, as the manufacturer of the block library takes care of the entire communication to the field instrument when creating the function blocks. The result is a complete function block in the graphical programming language FBS (Funktionsbausteinsprache/function block language), which gives the user access to measured values, faults, parameter settings of the field instrument in the PLC and also serves as an interface to the parent control technology. The function blocks, therefore, have an OPC-based configured interface for simple integration in the control system.

Using PROFINET communication means that in future not just one measured value will be available in the application program (as is the case with 4...20mA two-wire communication), but all the measuring and diagnostic information provided by the instrument.



### Customer benefits:

- Direct access from administrative level to field instrument
  - Thus direct integration of instruments
  - Also direct identification of faulty instrument in the event of a fault
  - Bidirectional communication and parameter setting of field instrument
- Saves on hardware
  - No need for PLC input modules (analogue as well as master modules for fieldbus technology)
  - Isolation amplifier (between measuring device and PLC input)
  - Less wiring and connection technology (previously every single signal was individually routed)
  - Save on analogue output modules for measuring devices (multiple analogue outputs were required to transmit multiple parameters)
- All the available measuring and diagnostic data in the measuring devices can be transmitted over one communication channel
  - Simpler integration into control technology, thus lower engineering costs
  - Homogenous standardised cabling from the control room to the field instrument via defined Ethernet cable
  - Advantageous connection to small and mid-sized controls which feature PROFINET as standard.
  - Less downtime by simply swapping instruments

### Products used:

- OPTIFLUX 2300 C/F
  - PROFINET communication via standard M12 connector
  - DN2.5...3000
  - Measurement of flow, conductivity, temperature, flow speed and other diagnostic parameters
- Control technology:
  - ILC 3xx PN
  - RFC 4xx PN
  - Axioline
- Waterworx function block library
- Web-based HMI/SCADA Atvise
  - Water management visualisation object library
- Acron archiving and reporting trend graph
- AIP Alarm Information Portal
- PROFINET network components
- 19" technology
  - Switches
  - Patch fields
  - Rack-mounted PCs



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